SOLAR THERMAL TECHNOLOGY

A Technology Overview

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Presentation Outline

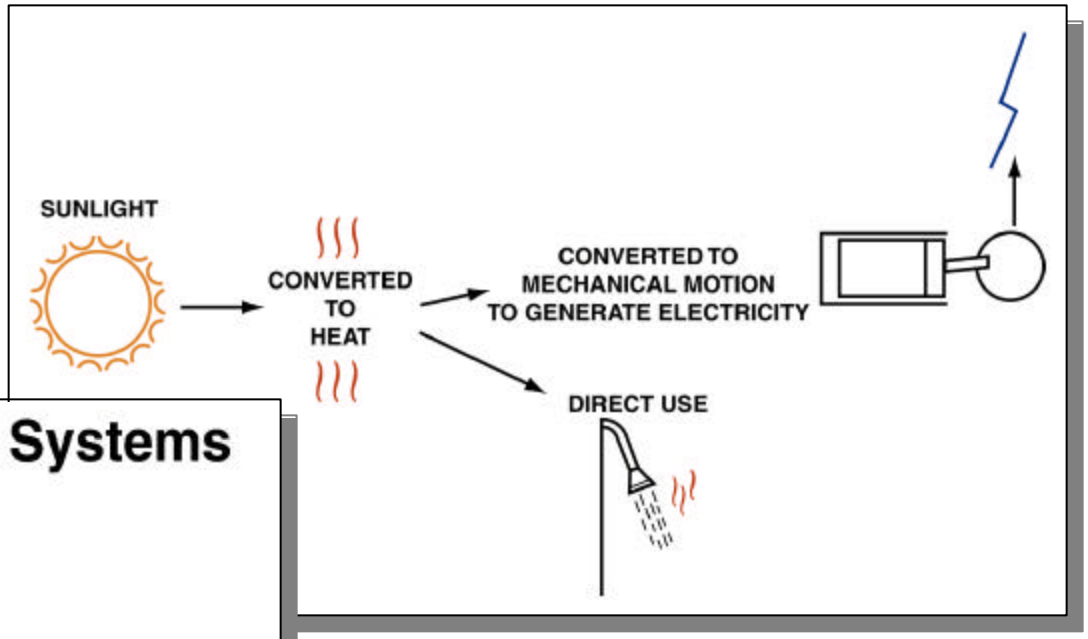
1. Review of the solar thermal technologies
2. Solar hot water and solar pool technologies
3. Emerging new technologies from DOE Labs
4. New problem areas
5. Summary

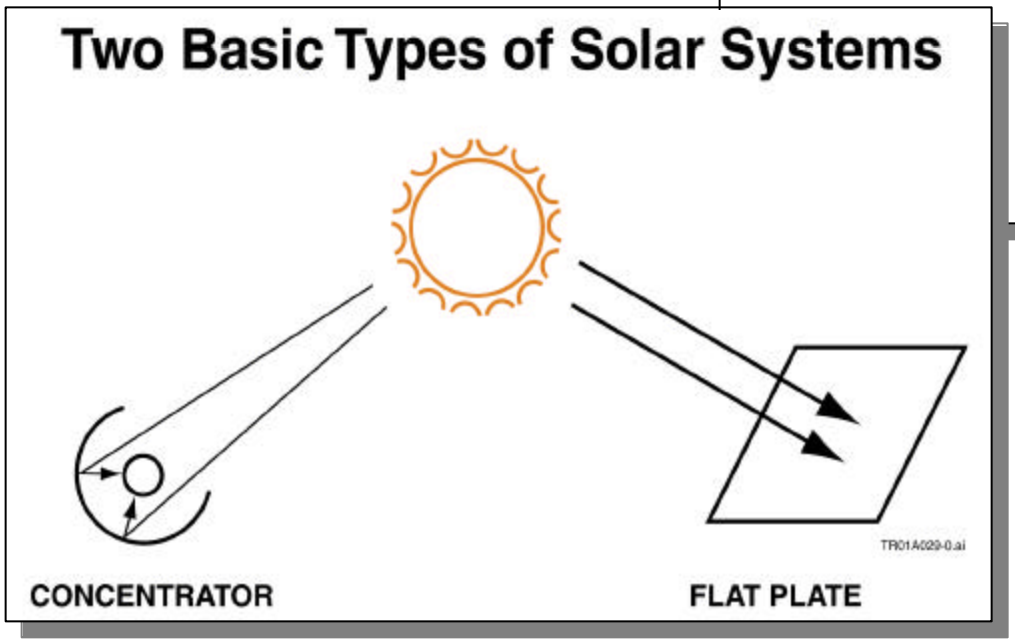
A Little Background on Sandia

- DOE National Lab, 8000 staff, $1.8B
- Multi-program engineering lab with defense emphasis
- Work in distributed & renewable energy for 25 yrs

- Hundreds of people; thousands of years of collective experience

Fundamental Concepts of Solar Thermal Technology





Large-Scale Solar Power Plants

Solar 1 Power Tower (10MW)

SEGS Trough Plant (354MW)

Mid-Sized Solar Plants

Trough Water Heater for Prison (5000 sq. feet)

Flat Plate Water Heater for Hospital (3000 sq. feet)

Small-Scale Solar Systems

Solar Hot Water System on Mess Hall

Solar Hot Water

Solar Hot Water Systems

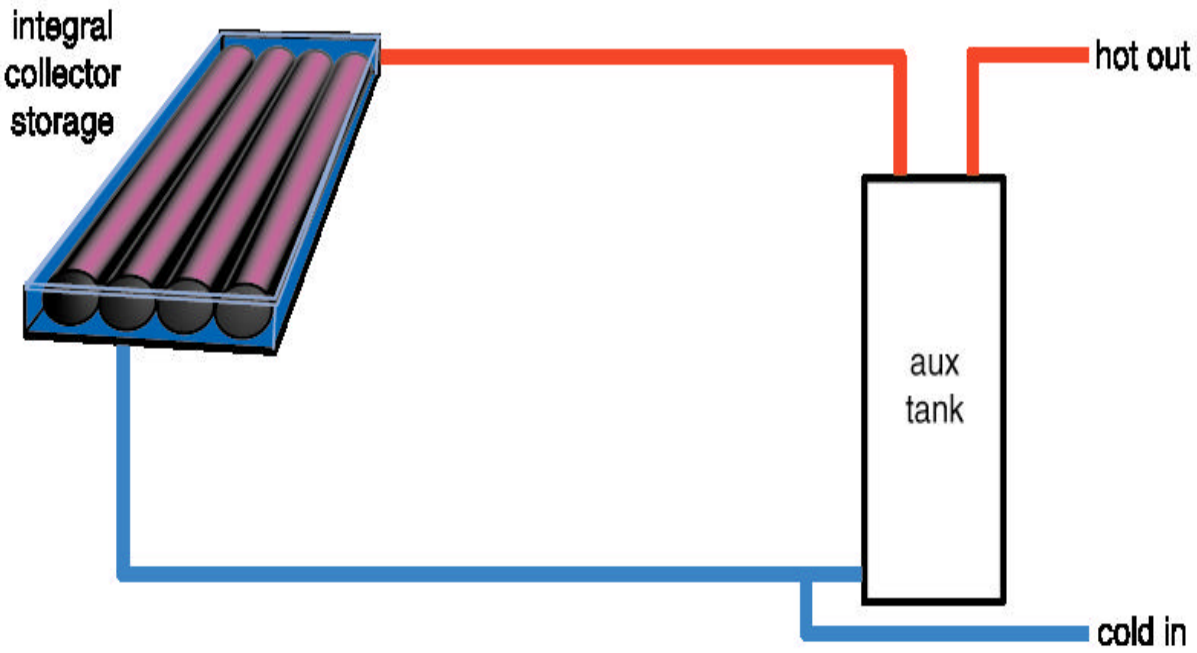
Residential Solar pool system-racked

Residential Solar pool system—on roof

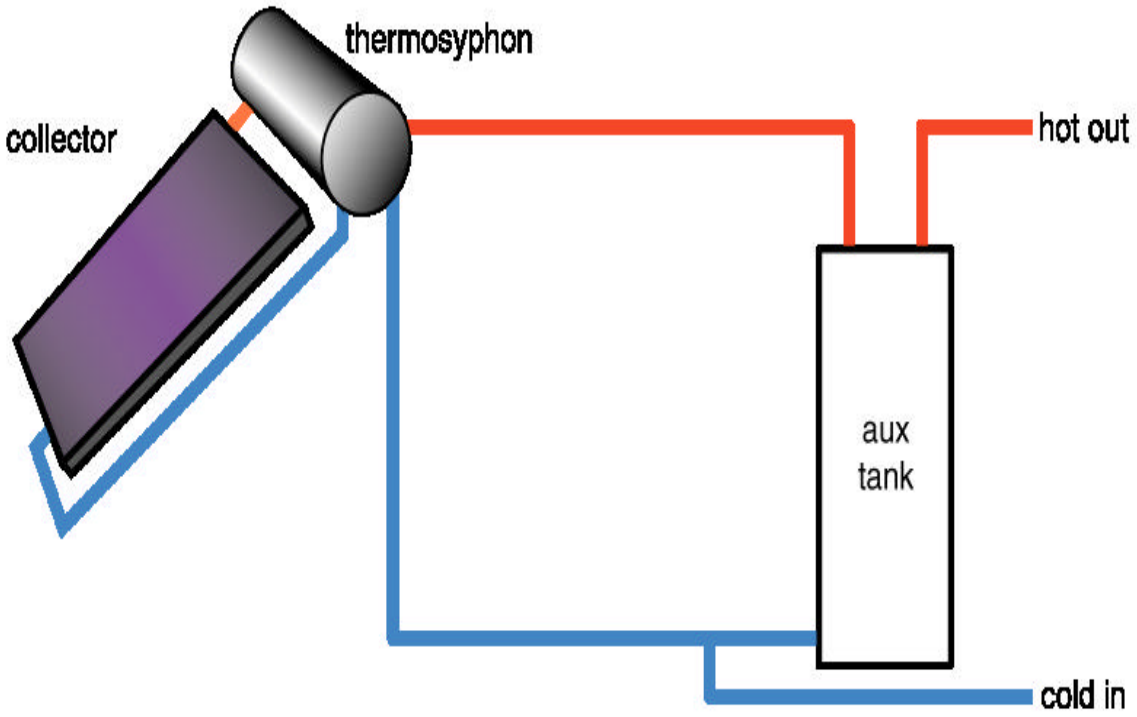
Solar Hot Water Systems

Residential Solar pool system—integrated into roof

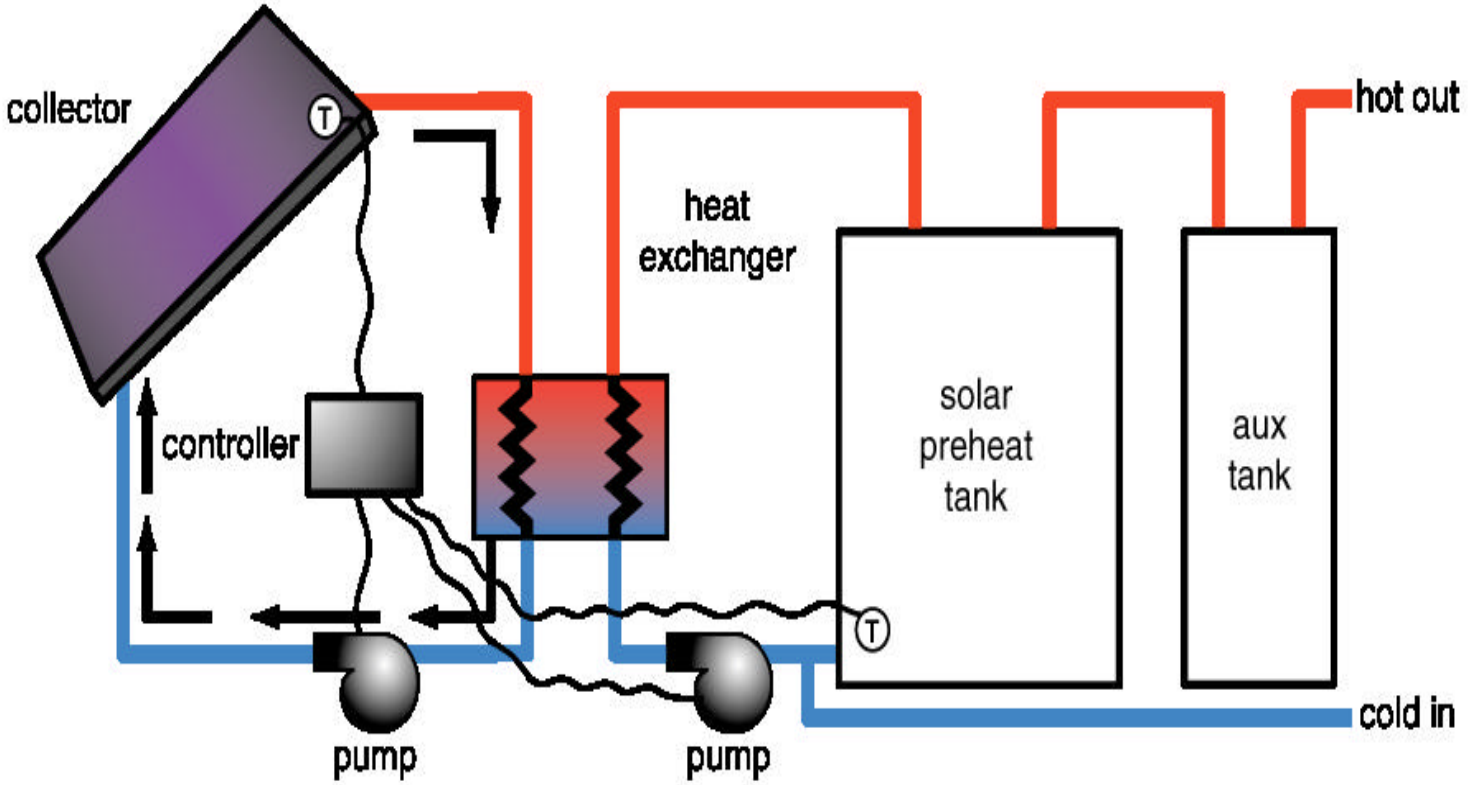
Integral Storage System



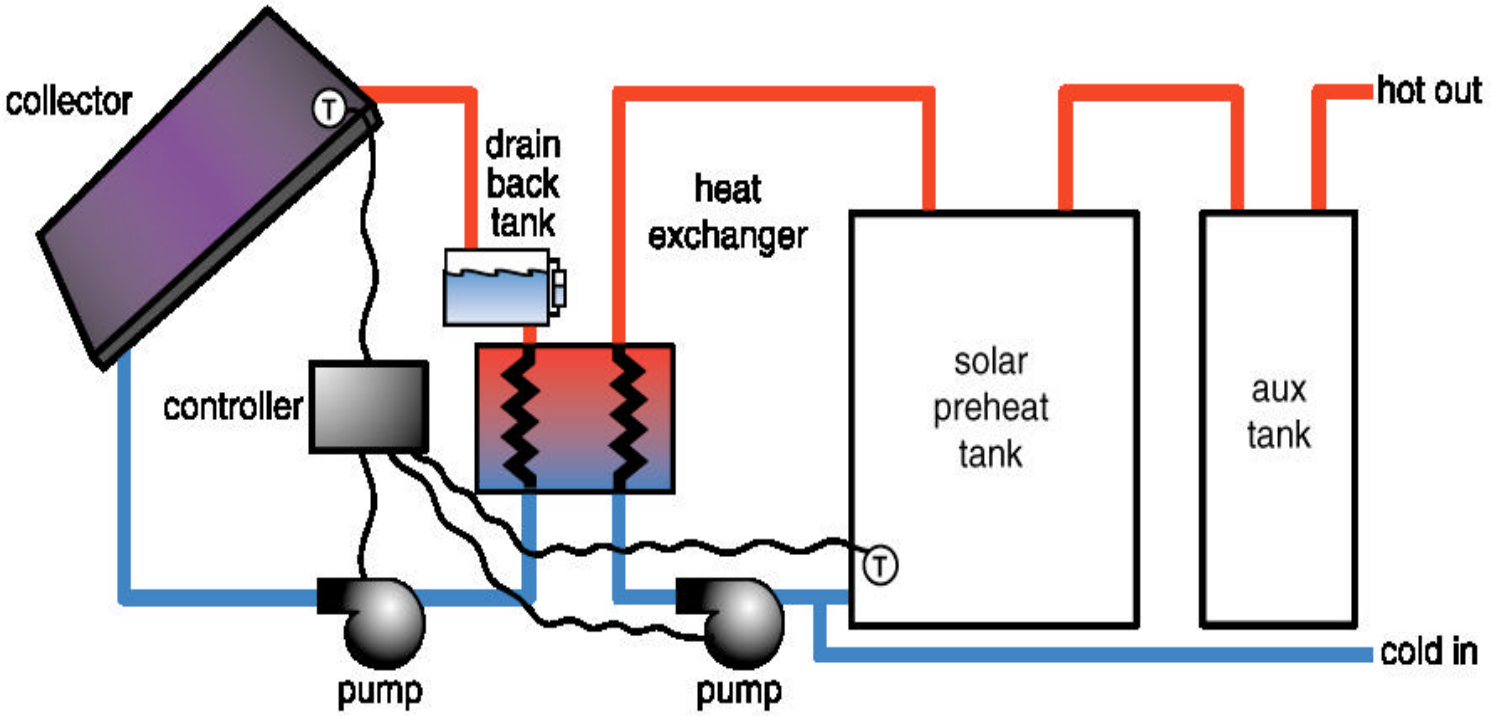
Thermosiphon System



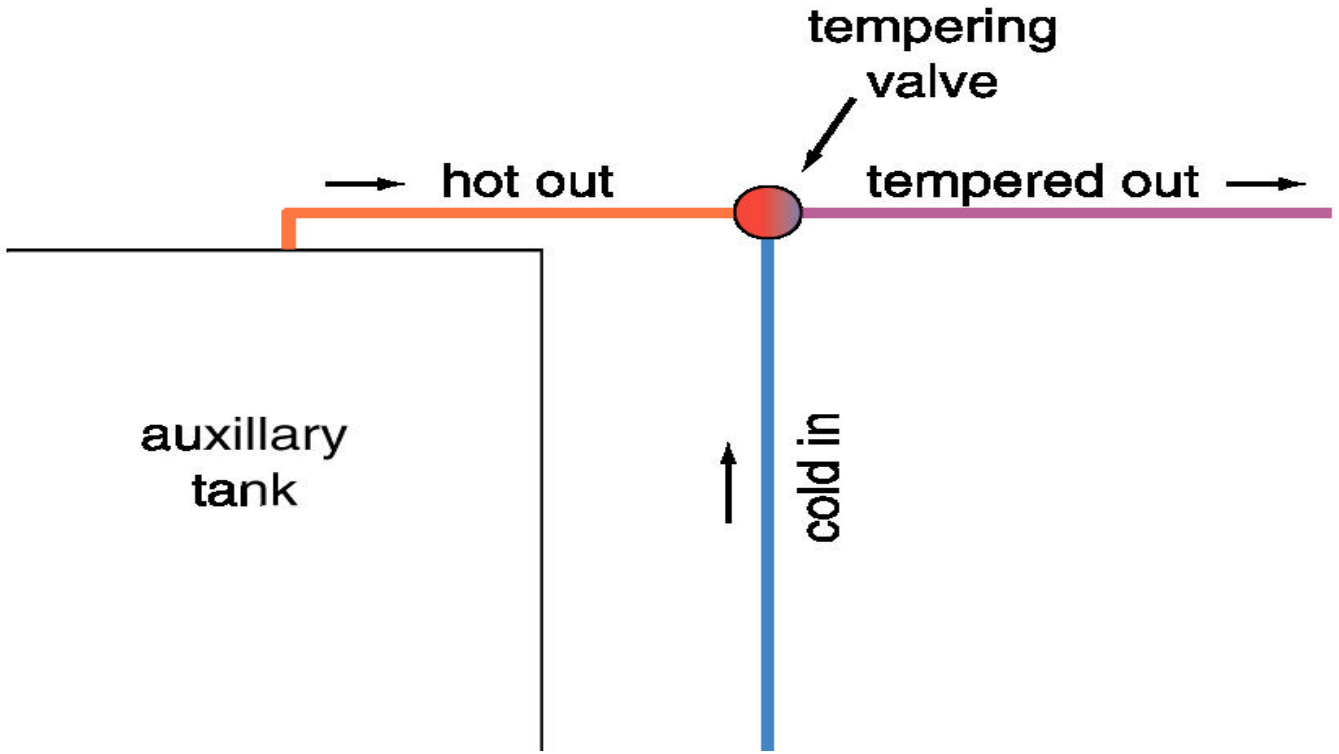
Active Closed Loop System



Active Drainback System



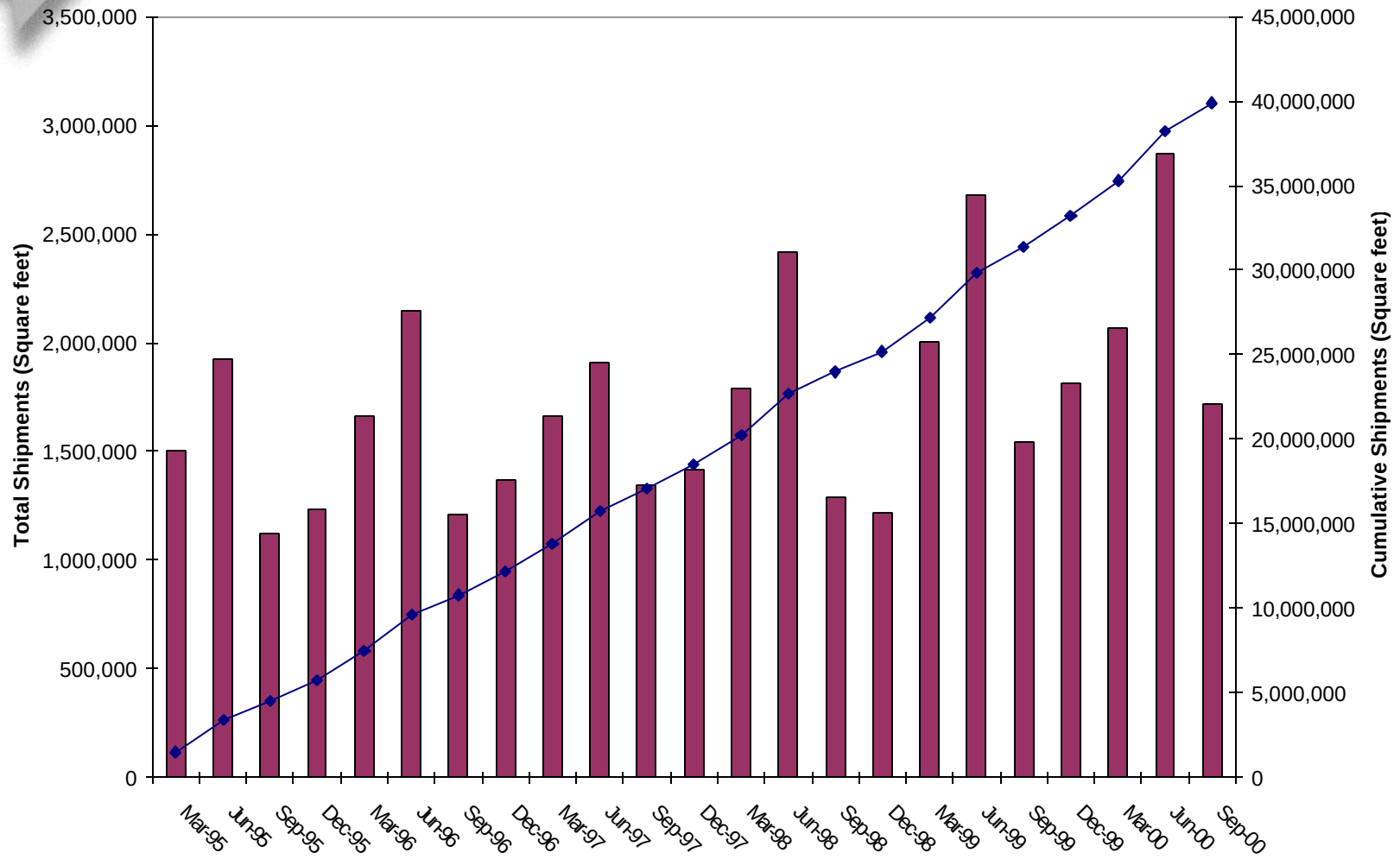
Tempering Valve



Solar Pools

Solar Pool System

Shipments of US-Manufactured Unglazed Collectors by Quarter

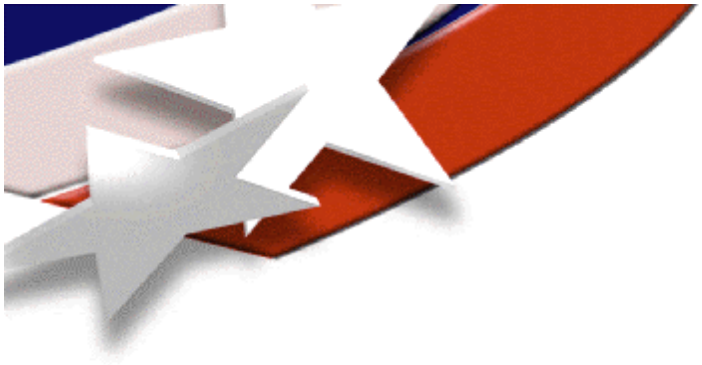


Solar Refurbishment

Solar Thermal System Refurbishment

- Old systems can serve again
- Avoid pitfalls:
  1) Inspect for leaks and corrosion
  2) Develop a plan and budget
  3) Hire contractor, make repairs
  4) Monitor performance
- Sandia's manual available

Solar Refurbishment Projects at Camp Pendleton and 29 Palms



Successful Applications

FT. HUACHUCA
Solar Pool, Barnes Field House

- 2,000 sf unglazed collectors
- 3,500 sf indoor pool
- $35,000 installed (mid 1980s)
- Annual savings of $5,400
- Simple payback 7 yrs

US COAST GUARD
Kiai Kai Hale Housing Area, Honolulu HI

- 62 flat plate, solar hot water
- Active systems
- $3200 each (w/rebate)
- $822/year savings
- 4 year simple payback

Federal Correctional Institution, Phoenix, AZ

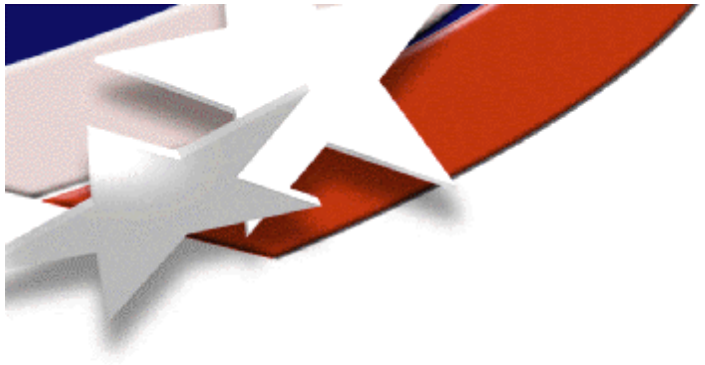
- 17,000 sf parabolic trough
- Installed cost $650,000
- Saves $96,000/ year at 0.064/kWh.
- Financed under ESPC
- 20 year contract, guaranteed savings

Solar Hot Water and Solar Pool Cost Break-Even Points

- Solar hot water systems compete with:
  - natural gas at about $7/MMBTU
  - electricity at about $0.03/kWH
- Solar pool systems compete with
  - natural gas at about $4/MMBTU

Solar Hot Water Success Factors

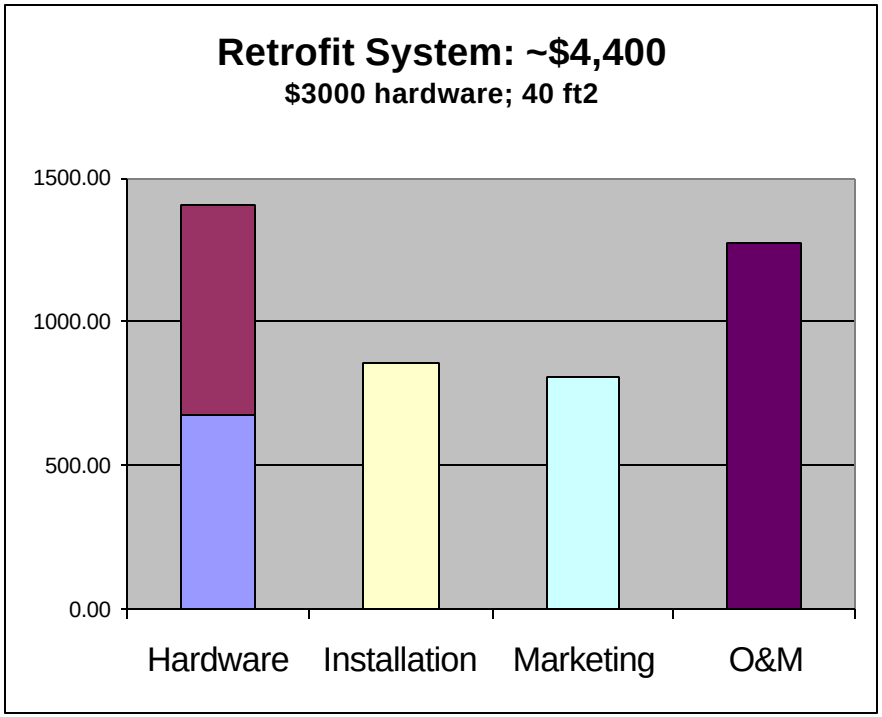
- Local champion
- Appropriate application with good payback
- Proven technology
- Professional design and installation
- Requires no manual intervention
- Performance indicators
- Clear service warranty
- O&M commitment



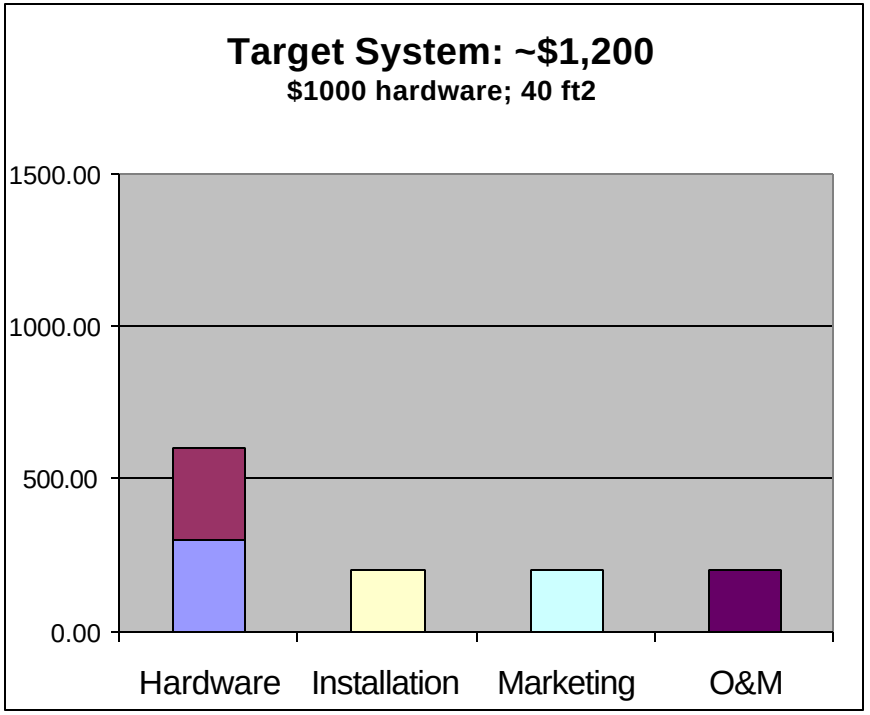
Technologies Emerging from DOE Labs

DOE Solar Water Heating Cost Goals

Today



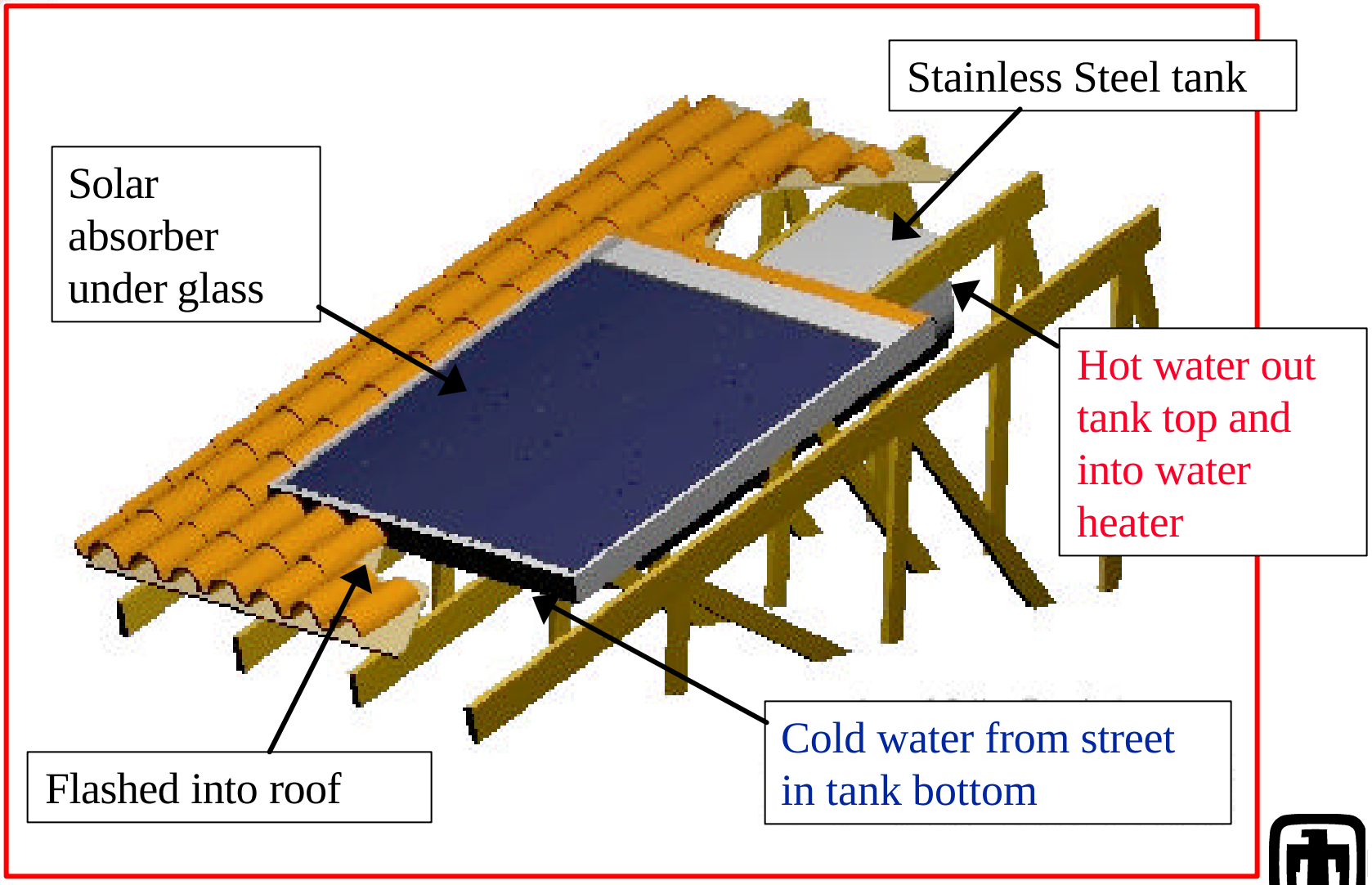
Goal



New Solar Hot Water Heating Technology

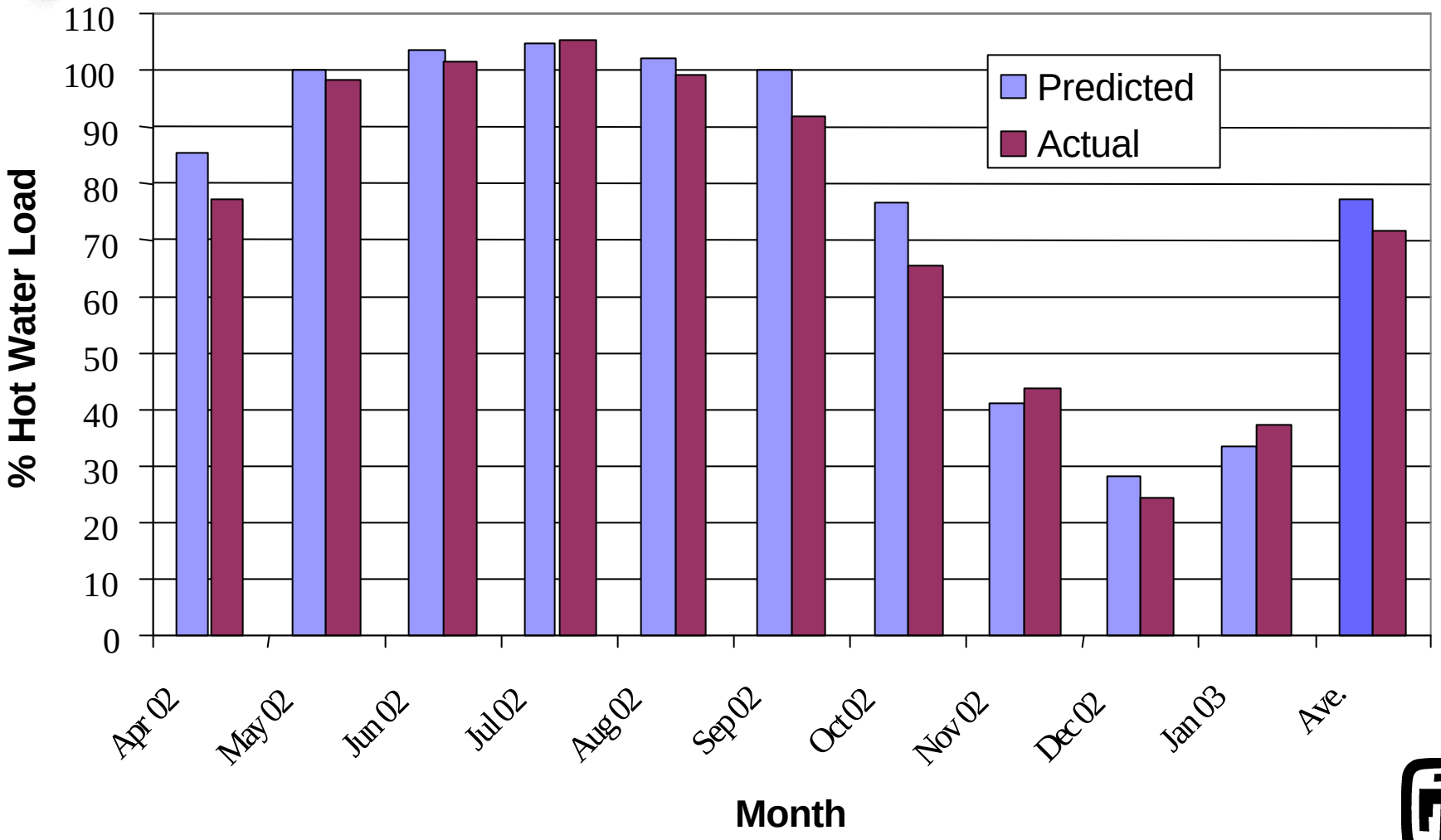
- Cooperative Research and Development Agreement with SRP
- Goal: develop new solar water heating system
- Passive design, integrates into roof
- All stainless steel
- Installed cost goal of $1500
- Three prototypes tested in Phoenix
- Planned tests at MCAGCC/29 Palms, Ft. Huachuca, MCB/HI, Tucson

System Sketch

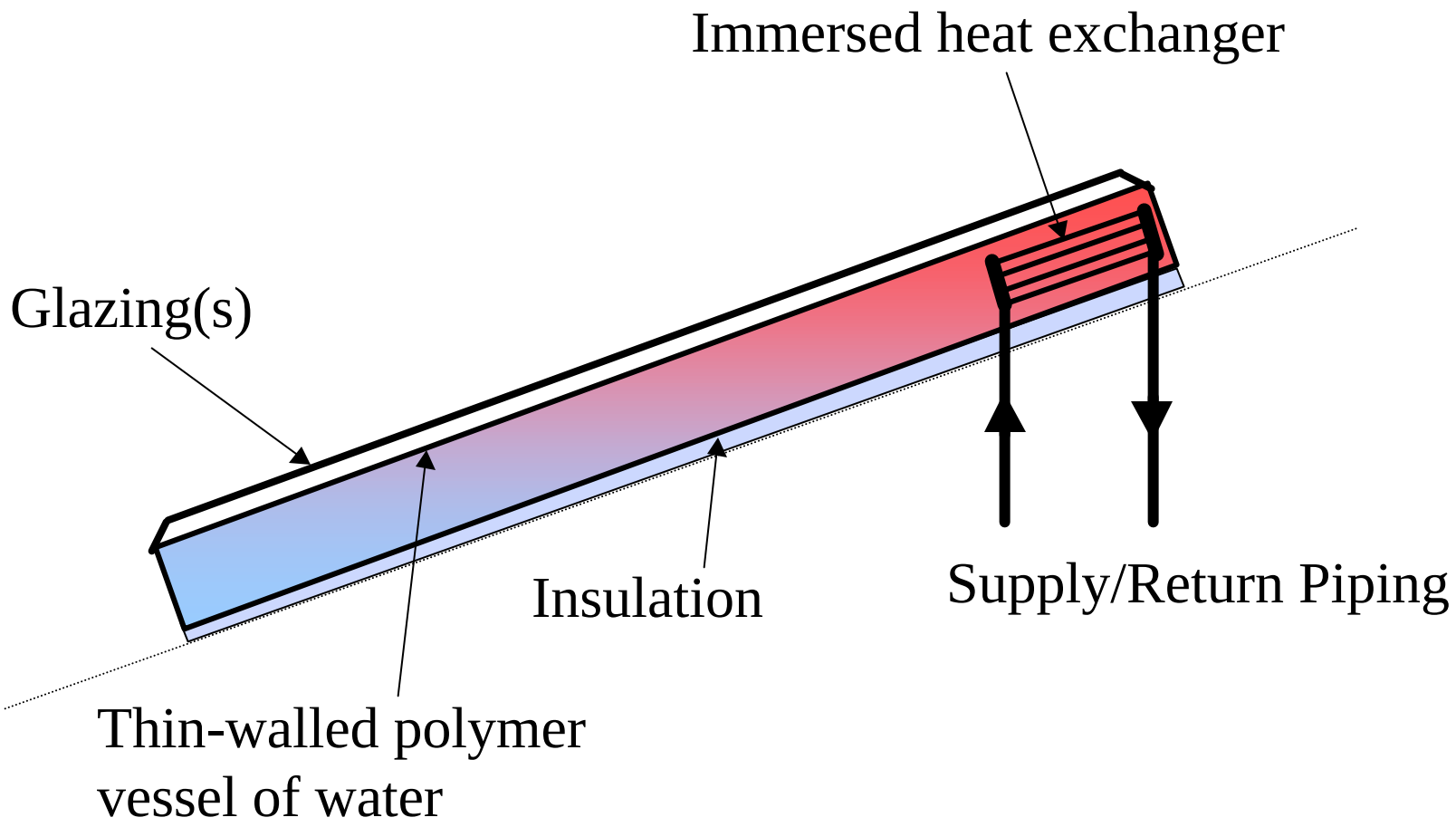


RITH Units Installed in Phoenix

Actual and Predicted Performance



NREL Guided Design of Polymer Water Heater

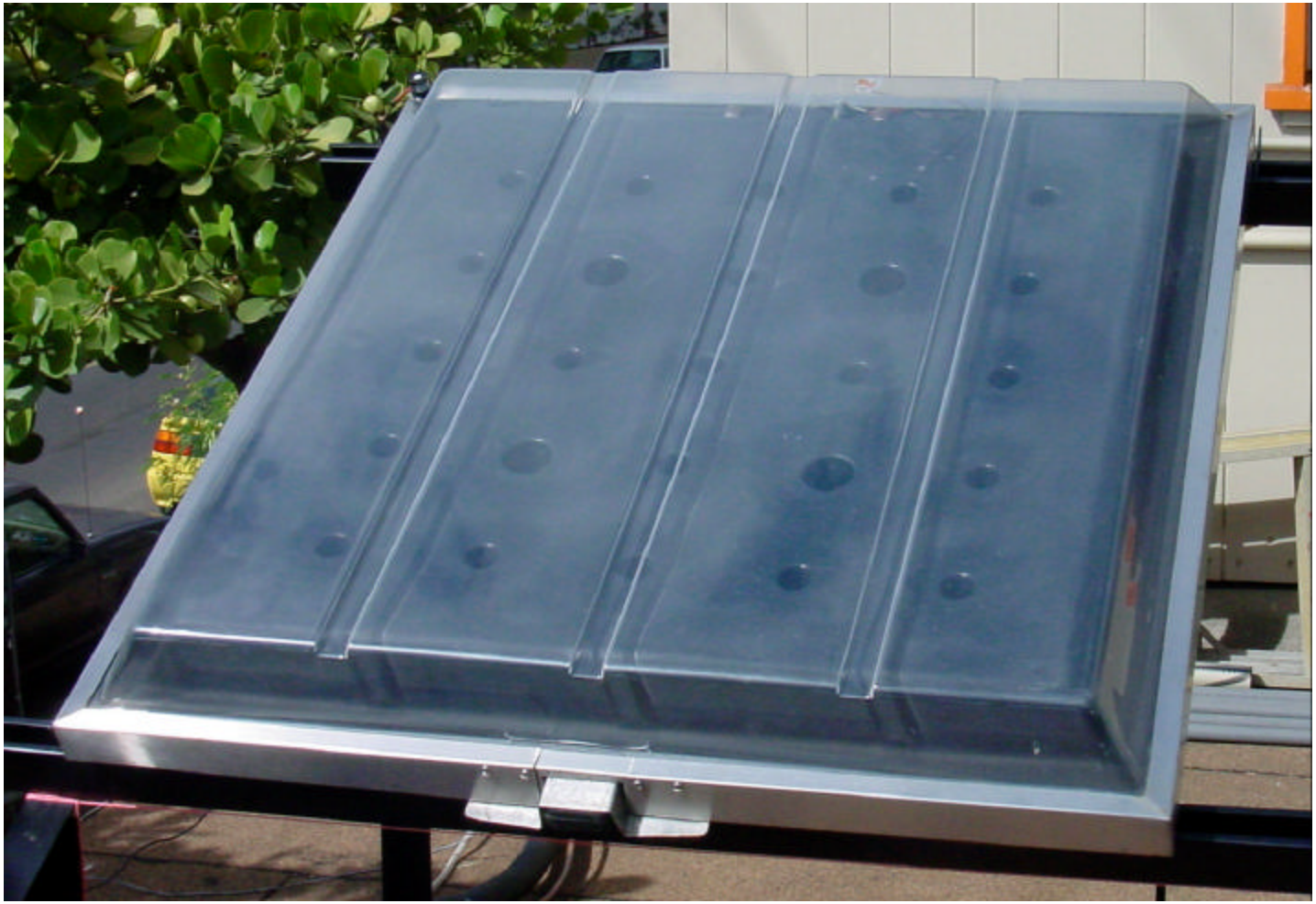


Technical Challenges (Barriers):

- Polymer durability is key issue
- System performance
  - Overheating protection
  - Heat exchanger sizing and placement
- Building codes
  - Plastic flammability
  - Structural concerns, e.g., wind loading
- Manufacturing process design
  - Thermoforming molding temperature tolerances

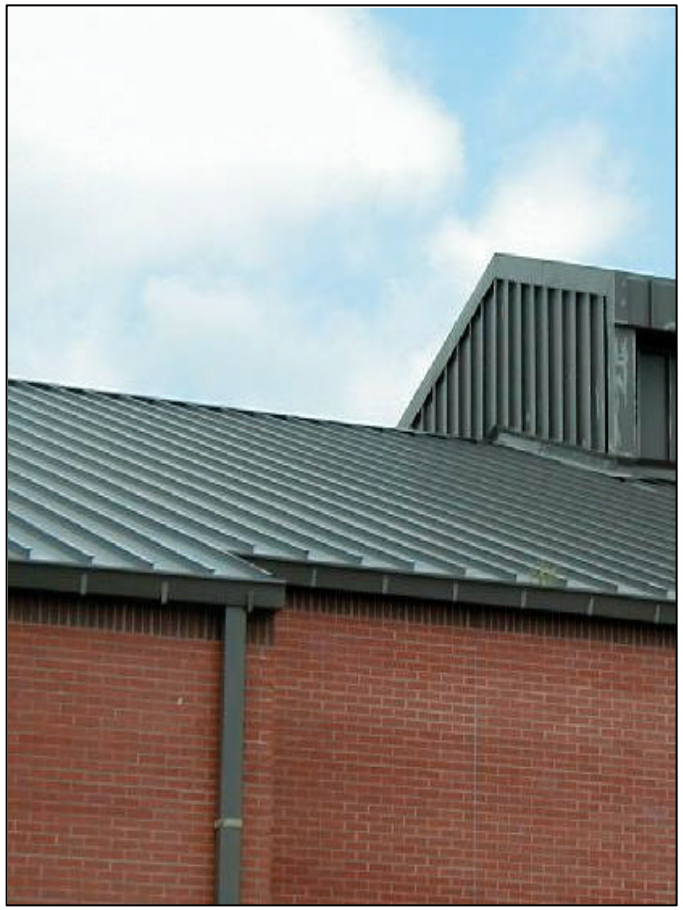
Prototype Polymer Water Heater

Prototype Polymer Water Heater

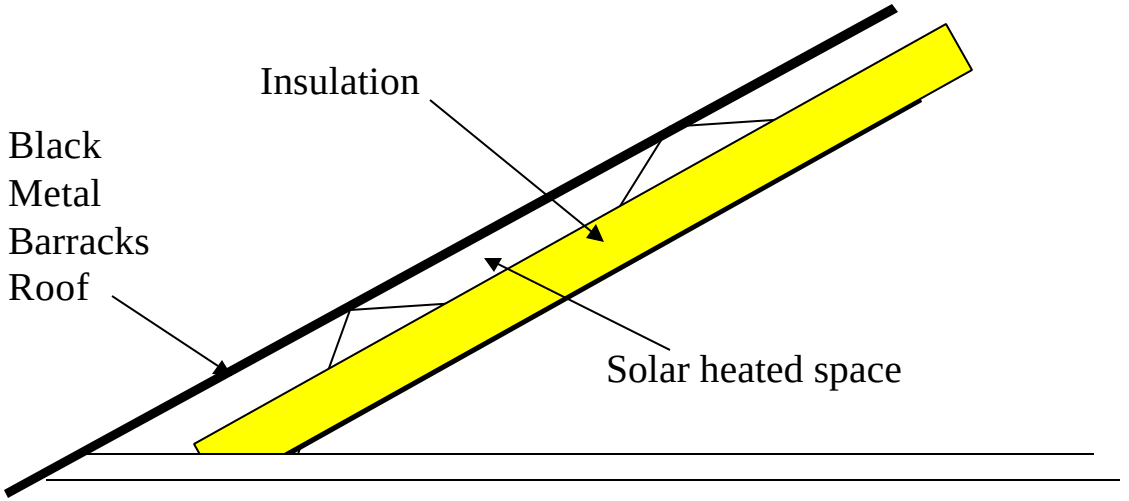


Solar Attic Hot Water Project at Ft. Huachuca

Scavenge heat from attic to heat water

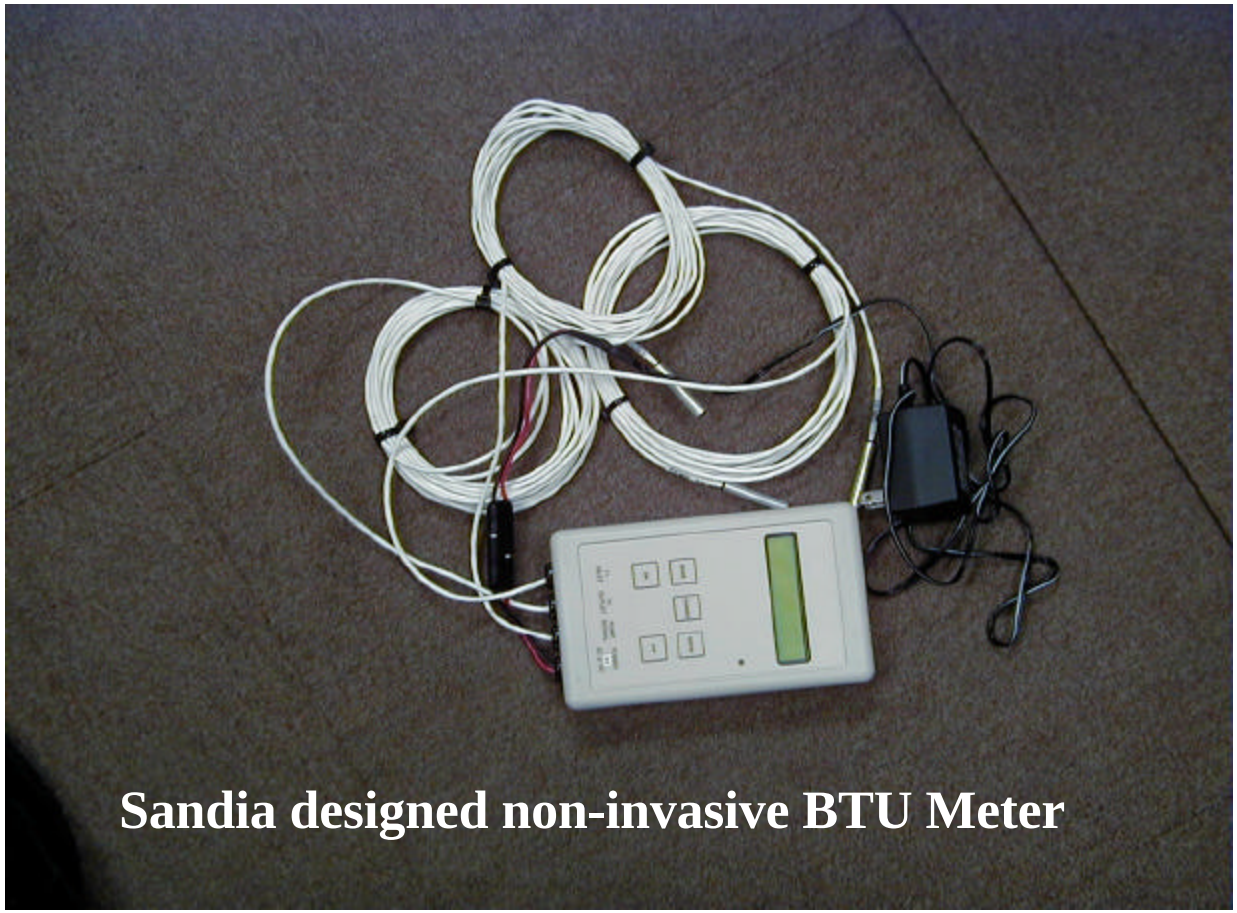


STANDARD CORPS of ENGINEER BARRACKS ROOF

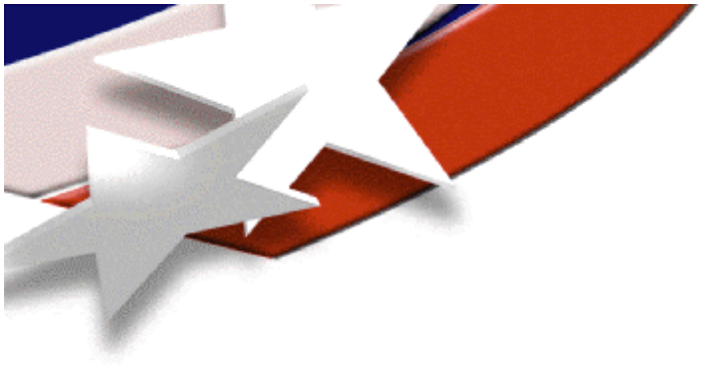


Sandia Designed Low-Cost BTU Meter for Solar Thermal Applications

- Easy monitoring
- No cutting pipes
- Patent pending; manufacturer selected
- Low cost for active/passive systems.



Sandia designed non-invasive BTU Meter



New Problems

Corrosion in Copper ICS Collectors in Tucson

- 200 ICS units installed in subdivision
- 12 collector failures due to pitting corrosion
- All failures from a single manufacturer
- Corrosion a function of temperature and aggressive water
- Thinner walled collectors at highest risk
- Copper corrosion not unusual, but not a pervasive problem

Resources and References

- **American Society of Heating, Air Conditioning and Refrigeration Engineers, Inc.**

  ASHRAE 90003 -- Active Solar Heating Design Manual

  ASHRAE 90336 -- Guidance for Preparing Active Solar Heating Systems Operation and Maintenance Manuals

  ASHRAE 90346 -- Active Solar Heating Systems Installation Manual

- **Solar Rating and Certification Corporation**

  SRCC-OG-300-91 -- Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems

- **FEMP Federal Technology Alert "Solar Water Heating"** (Call 1-800-DOE-EREC for copy)

To get Help:

- Solar Energy Industries Association and local chapters
- Federal agency personnel that have experience operating solar projects
- State energy offices
- FEMP/NREL/Sandia National Laboratories (505-844-3077)